Toponym Extraction from Selected Historic Topographic Maps Using Deep Learning

by **Gongmingyue Tang**

Historical maps are import sources and toponyms are essential components of maps. The author proposed a deep-learning pipeline that aims to contribute to the transformation of historical map scans into structured geo-data. The thesis trained a text detection model to seperate the place names from background and applied deep learning based text recognition to transcribe the segemented rasters to digitized words. The pipeline was tested on selected topographical map sheets from Saxonian Land Survey (1780 – 1825).

Selected Map Series

The target maps of this thesis are the selection sheets of the map series from the third major survey of Saxony from 1780 to 1825 at a scale of 1:12.000. The Saxon Mile Sheets, named after their units of measurement, are of high accuracy in their geometry and exceedingly detailed [1].

The preprocessing steps include colour homogenization to increase the contrast, reprojected to obtain an orthographic view of mapped objects, and text shape extraction and generalization to generate the font style.

Workflow

The processing was divided into three parts in general (see fig.1). From data preparation to text detection, then, at last, the recognition, the outcome of each part was taken as the input for the next. Since sequential execution brings the potential problem that the downstream stages highly depend on the results of upstream implementation, there are evaluation and calibration steps in each part. Steps were revisited when the outputs were not satisfied.

Data Preparation

Synthetic data are generated to save the effort of manually labeling training samples in deep learning approach. The text was randomly chosen from a list of possible place names or a random sequence of letters. The text was rendered with a customized antique font and at font size 80. The rendering colour is randomly from dark brown to black, and a small part of light brown. The vector graphic was then rasterized. The text was rotated 39 degrees counterclockwise before being overlaid on the background layers. the text was rotated 39 degrees counterclockwise before being overlaid on the background layer. Data augmentation techniques were applied to increase the availability and diversity of training data.

Text Detection

The author adopted a UNet architecture to separate text elements from the graphic. For model input, the original map sheets were downsized and divided into 128 *128 patches for fitting memory purposes.

The binary segmentation results were then processed with morphological operations for shape enhancement and noise removal. By applying the morphological closing with a horizontal kernel, the text pixels were connected to form toponym objects. The place names were cropped with the detected minimal enclosing boxes (see fig.3(A)). The locations and addresses of word boxes were queried with the help of geocoding API, Nominatim, for further contextual analysis.

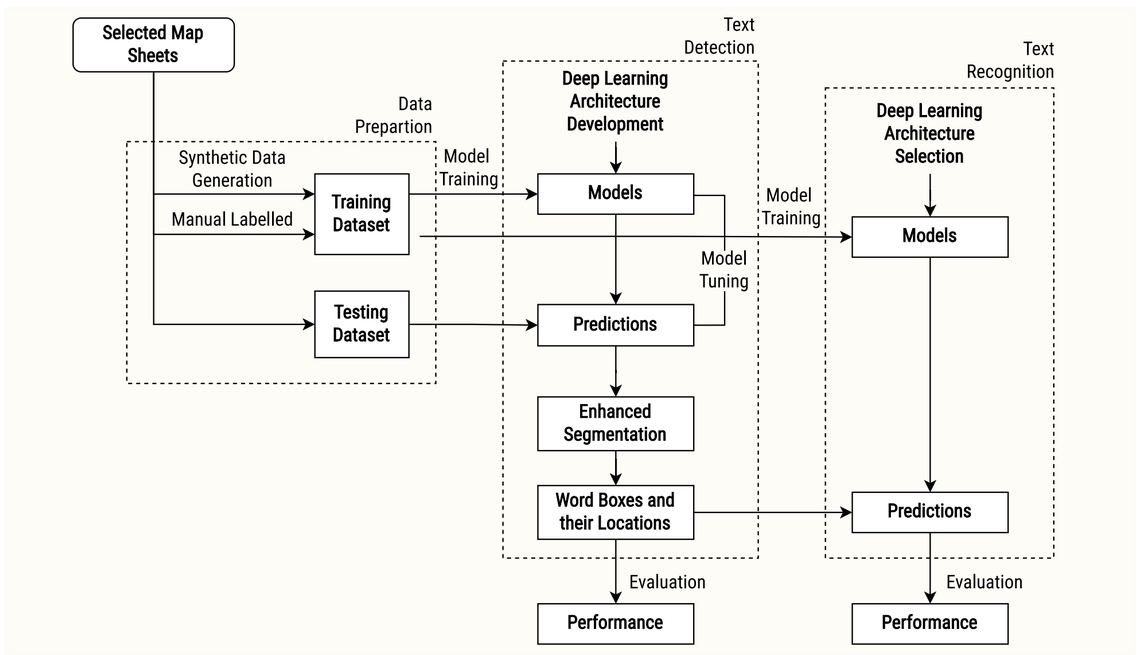

Fig.1 General Processing Workflow of Text Extraction

Fig.2: Generation of training data. From top to bottom are the process of generating synthetic data, manually labelled ground truth, and true nagetive samples.

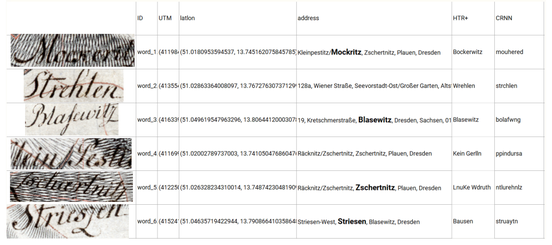

Fig.3: (A) Detected place names from a map sheet. (B) The results of toponym localization and recognition

Text Recognition

The recognition was conducted in MMOCR [2] and Transkribus [3]. Models trained on HTR+ engine, CRNN+STN and ABiNet architectures were tested and compared. The best performance was produced by the model trained with Syn90k dataset (see fig.3(B)). The increment of training samples was proved to significantly improve the recognition results.

Conclusion

1. The comparative experiments found the gap between the performance of different pretrained extraction and recognition models.

2. Synthetic data proved its feasibility of saving efforts for deep learning models in text extraction.

3. For existing open-source text recognition tools, recognizing handwritten place names on historical maps with unique font styles is still very challenging.

Thesis Conducted at

Institute of Cartography
Department of Geosciences
Technische Universität Dresden

TECHNISCHE UNIVERSITÄT DRESDEN

Thesis Assessment Board

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Year

2022

Keywords

Text Extraction, Historical Maps, OCR, Deep Learning

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This master thesis was created within the Cartography M.Sc. programme – proudly co-funded by the Erasmus+ Programme of the European Union.

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